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Case Report

Early adipocere formation: A case report and review of literature

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ABSTRACT

Adipocere has a long history of frightening and fascinating mankind, from so called "incorruptible saints" to the famous "iceman" and its formation on human remains has long been known and feared. Adipocere formation replaces the putrefactive changes, when the body lies buried in shallow, moist, clay, soiled grave or it is thrown into cess pools or submerged in water. As the progression of putrefaction is arrested, the facial features and wounds are preserved without much alteration, thereby aiding the identification and to certain extent, the cause of death. The time required for the formation of adipocere is a subject of controversy. Here we present a case of early adipocere formation within 3 days and the review of literature pertaining to it.

1. Introduction

> "*In a Hydropicall body ten years buried in a church yard, we met with a fat concretion, where the nitre of the earth, and the salt and lixivious liquor of the body, had coagulated large lumps of fat into the consistence of hardest castle soap: whereof part remaineth with us*"

These were the words of Sir Thomas Browne (1605–1682) in his discourse, *Hydriotaphia, Urn Burial*, the first known published scientific reference to the fatty, waxy, soap like substance derived from the decaying human corpses buried in moist, air free places, although it was generally believed that Frenchman Fourcroy is the first to discover it in the 18th century.[1] Adipocere, the name given to this post mortem change by Antoine Francois Fourcroy in 1789, being derived from the word 'adipo' and 'cire', to indicate its affinity with both fat and wax. It is a firm greyish white to brown wax like material composed of mixture of saturated fatty acids including myristic, palmitic and stearic acids. Salts of fatty acids and 10-hydroxystearic acid are regularly identified in adipocere; however their presence appears to be dependent on decomposition environment.[2]

This is a result of early activity of anaerobes such as *Clostridium perfringens* which produce the enzymes lecithinase, facilitating hydrolysis and hydrogenation leading to formation of adipocere. In burials, immersion in water and incarceration in vaults and crypts, adipocere often forms to varying extent.[3–5] The smell was accurately described as being 'earthy, cheesy and ammoniacal'.[6,7]

The time required for the production of adipocerous change varies from one geographical area to another depending on the environmental conditions. Detailed review of the literature showed the time required for adipocere formation varied from 3 days to 5 years. Here, we describe a case where these changes were observed well within 3 days of death. The body of a person, told to be missing, was recovered from a marshy pond within 65–66 h after death. The body showed extensive adipocerous changes with well preserved gunshot injuries, which enabled us to establish the cause of death.

2. Case report

On the night of 13th October 2007, Mr. X aged 35 years left his home at 11 o'clock along with three other people believed to be his friends, promising his wife to be back in a short while. Not finding him until the next morning, his wife lodged a complaint to the police. Police interrogation of the deceased friends confirmed the death of Mr. X, within an hour of leaving home by shooting with the help of a muzzle loading shotgun and the body being disposed in a nearby marshy pond. The dead body was recovered on 16th October 2007 at 5 o'clock in the evening and was subjected for medico-legal autopsy. The dead body was identified by the police with the help of the wife of the deceased by examining the articles

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present on the body, clothing, contents of the wallet and the physical parameters.

Post mortem findings: Body showed adipocerous changes over the cheeks, front and back of the trunk, upper limbs except the hands and lower limbs except the feet (Fig. 1). The adipocerous areas were yellowish white in colour, soft, greasy and had a strong odour like that of ammonia. Artefacts produced by the aquatic animals were present over the peri-orbital areas, nose, ears, genitalia and limbs. A circular lacerated wound with deposition of soot particles around it was present on the back portion of the chest (entry wound of gunshot) (Fig. 2). Another lacerated wound was present on the front portion of the neck (exit wound of gunshot). No projectiles were recovered from the body cavity (whole body was radiographed to detect the projectiles prior to autopsy). Ribs were fractured along the para-vertebral area corresponding to the entry wound. The internal structures showed uniform reddish brown discoloration with well preserved architecture of the viscera.

3. Discussion

Lipids represent approximately 60–85% of the body fat with the other major constituent being water. Lipids comprise approximately 90–99% triglycerides, which contain numerous fatty acids attached to the glycerol molecule. In the human body, the mono-unsaturated oleic acid is the most widespread in adipose tissue. The polyunsaturated linoleic acid and mono-unsaturated palmitoleic acid are also prevalent. The corresponding saturated palmitic acid is also extensively distributed in fat depots.[2]

Fig. 1. Body showing adipocere formation.

Fig. 2. Entry wound of the gunshot.

After death, the body fat is hydrolyzed by intrinsic lipases to yield a mixture of fatty acids that may undergo further hydrolysis or oxidation, depending on the surrounding environment.[2,8] In an aerobic environment, conditions will favour oxidation, and the unsaturated fatty acids released by post-mortem hydrolysis will convert to aldehydes and ketones through the oxidative actions of the fungi, bacteria, and the air.[9] Oxidative changes are less likely to occur than hydrolytic changes in a burial environment because the decomposing body is continually exposed to reducing conditions.[2] In an oxygen deficient environment, the mixture of unsaturated and saturated fatty acids released during post-mortem hydrolysis will undergo further hydrolysis and hydrogenation. The concentration of free fatty acids will increase with a concomitant reduction in neutral fat as decomposition proceeds. Extensive hydrolysis is enhanced by the presence of bacterial enzymes and moisture.[10] Various clostridia species yield powerful lipolytic enzymes that significantly aid the anaerobic hydrolysis and hydrogenation of body fat under warm conditions. Particularly *C. perfringens* (welchi) has been identified as a major agent for decomposition of a cadaver because it resides in the human intestinal tract and has strong saccharolytic, proteolytic, and lipolytic capabilities.[2,11] Moisture is essential for the survival of the bacteria and subsequent hydrolysis of neutral fat, and sufficient moisture is usually present in the fatty tissues for the reaction to commence.[12] Providing there is sufficient moisture and enzyme activity, the process will continue until the original fatty tissue is reduced to a mass of fatty acids. If this process occurs under suitable conditions, the formation of adipocere will occur.

Adipocere formation may occur in any site whereby fatty tissue or lipids are present prior to death, including internal organs such as the heart, kidney and liver. Furthermore, adipocere formation can occur in tissues with minimal fat content due to the translocation of liquefied fat and subsequent diffusion into the tissue.[2] Freshly formed adipocere has a soft, wet, paste-like appearance and can demonstrate a strong ammoniacal odour in a waterlogged environment.[13] This characteristic ammoniacal odour helps the cadaver dogs in detecting clandestine burials.[14] Older adipocere material becomes dry and brittle with a white or soapy appearance.[2,13] It is generally more prevalent in individuals with a high fat content, particularly in women and children.[15]

The formation of adipocere in aqueous environments has been documented by Cotton et al.,[16] Mant and Furbank,[13] Dix,[17] Takatori and Yamaoka,[18] Mellen et al.,[19] Mackenzie,[20] Dikshit,[21] Subramanyam,[22] and Umadethan.[23] Complete transformation of all soft tissues to adipocere in water setting may occur in as little as 3 days, and has also been documented in cases up to 5 years after death (Table 1).

Table 1
Time required for adipocere formation in bodies immersed in water.

Author (year)	Time period
Cotton et al. (1987)	5 years
Mant and Furbank (1957)	1 year
Dix (1987)	6 months
Takatori and Yamahoka (1977)	4.5 months
Mellen et al. (1993)	2.5 months
Somonsen (1977)	3 weeks
Mackenzie SC (1889)	3–15 days
Dikshit PC (2007)	3–35 days
Subramanyam BV (1999)	7–35 days
Umadethan B (2008)	3–7 days

The time required for the formation of adipocere depends on the optimal fulfilment of the climatic conditions. In Europe, it ranges from 3 months to 1 year, though the changes may begin within 5 weeks or may be delayed up to 3 years. Its development is rapid in bodies submerged in water than buried in soil. Dr. Coull Mackenzie has reported to have seen this change as early as 3 days (range 3–15 days) in bodies drowned in Hoogly River, while others have noted this change in 7–35 days.[20–22,24] Covering on burial bodies will also considerably retard decomposition and impact the preservation of soft tissue to varying degrees.[2,25]

Adipocere formation occurs within a limited temperature range, generally tied to the optimum growth temperature for the bacterium *C. perfringens* (welchi). Tomita[26] notes the lower limit as 21 °C, Corry[11] reports the optimum temperature to be about 45 °C, and Bryan et al.[27] reports the optimum temperature to be 35–37 °C. When the ambient temperature reaches a maximum or minimum, adipocere will not form due to a depression in the rate of bacterial action and enzymatic release.[11,12,28,29]

To the best of our knowledge this could be the first reported case of adipocere well developed within 3 days (65–66 h). In this geographical area the temperature varies from 30 to 35 °C with humidity of 80–90% during the October month. The warm temperature, high humidity along with submersion of body in marshy water and presence of favourable body constituents (adipose tissue) have contributed for early formation of adipocerous changes in this body. Clothing present over the body has considerably retarded the decomposition and helped to preserve the soft tissue to varying degrees.

In the present case, the cause of death could be established despite submersion of the body in water for more than 2 days as a result of adipocere formation. As there were no projectiles inside the body on radiological examination prior to autopsy, the vital clues regarding the homicidal gunshot injuries might have been overlooked rendering it to be an unsuspecting drowning case. Therefore, the preservation of anatomical form of wounds by the formation of adipocere and also the presence of blackening around one of the perforating wounds indicated the death due to gunshot injuries and gave the details regarding the entry and exit wounds. This helped the law enforcing agency to proceed in the direction of homicide investigation.

Conflict of Interest

Authors have no conflict of interest to be declared.

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Ethical Approval

Ethical approval is not applicable.

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